A203.2.1 Stormwater Management/BMP Preliminary/Concept Plan Checklist

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SWM/BMP PRELIMINARY/CONCEPT PLAN CHECKLIST Page 1 of 2

Please type or print legibly

Project Information

Project Identifier:_____
Location:_____
Project
Description:_____

General Information

No. of SWM/BMP Facilities?_____
Contributing Drainage Area to each SWM/BMP Facility:_____

Submittal Requirements

General Requirements:

Description	Yes	No	N/A
1. Common Address and legal description of site			
2. Vicinity Map			
3. Existing and proposed mapping and plans (not greater than 1"=100') which illustrate at a minimum:			
- Existing and proposed topography (minimum 2-foot contours recommended)			
- Perennial and intermittent streams			
- Mapping of predominant soils from County soil surveys.			
- Boundaries of existing predominant vegetation and proposed limits of clearing			
- Location and boundaries of wetlands, lakes, ponds and other setbacks (e.g., stream buffers, drinking water well setbacks, septic setbacks)			
- Location of existing and proposed roads, buildings and other structures			
- Location of existing and proposed utilities (e.g., water, sewer, gas, electric) and easements			
- Location of existing and proposed conveyance systems such as grass channels, swales and storm drains			
- Flow paths			
- Location of FEMA floodplain/floodway limits and relationship of site to upstream and downstream properties and drainages			
- Preliminary location and dimensions of proposed channel modification such as bridge or culvert crossings			
- Preliminary location, size, maintenance access and limits of disturbance of proposed structural stormwater management practices			
4. Hydrologic and hydraulic analysis including:			
- Preliminary analysis of potential downstream impact/effects of project			
- Preliminary selection and rationale for structural stormwater management practices			

Submittal Requirements			
Description	Yes	No	N/A
- Preliminary sizing calculations for structural stormwater management practices including, contributing drainage area, drainage divides, storage and outlet configuration			
5. Preliminary landscaping plans for structural stormwater management practices and any site reforestation or revegetation			
6. Preliminary erosion and sediment control plan that at a minimum meets the requirements outlined in local Erosion and Sediment Control guidelines (narrative form also acceptable)			
7. Identification of preliminary waiver requests			

A203.2.2.C Stormwater Management Plan Calculations

Rational Method Runoff Coefficients

$$Q = C\ C_f\ I\ A$$

Rational Equation Runoff Coeffients Table

Land Use		**"C" Value**
Business, industrial and commercial		0.90
Apartments		0.75
Schools		0.60
Residential	- lots of 10,000 sq. ft.	0.50
	- lots of 12,000 sq. ft.	0.45
	- lots of 17,000 sq. ft.	0.45
	- lots of ½ acre or more	0.40
Parks, cemeteries and umimproved areas		0.34
Paved and roof areas		0.90
Cultivated areas		0.60
Pasture		0.45
Forest		0.30
Steep Grass slopes (2:1)		0.70
Shoulder and ditch areas		0.50
Lawns		0.20

Source: VDOT

Rational Equation Frequency Factors Table

C_f	**Storm Return Frequency**
1.0	10 yr. or less
1.1	25 yr.
1.2	50 yr.
1.25	100 yr.

Source: VDOT

Values of Runoff Coefficient (C) for Rational Formula

Land Use		"C" Value
Business	- Downtown areas	0.70-0.95
	- Neighborhood areas	0.50-0.70
Residential	- Single-family areas	0.30-0.50
	- Multi units, detached	0.40-0.60
	- Multi units attached	0.60-0.75
	- Suburban	0.25-0.40
Industrial	- Light areas	0.50-0.80
	- Heavy areas	0.60-0.90
Parks and cemeteries		0.10-0.25
Playgrounds		0.20-0.35
Railroad yard areas		0.20-0.40
Lawns	- Sandy soil, flat 2%	0.05-0.10
	- Sandy soil, average, 2-7%	0.10-0.15
	- Sandy soil, steep, 7%	0.15-0.20
	- Heavy soil, flat, 2%	0.13-0.17
	- Heavy soil, average, 2-7%	0.18-0.22
	- Heavy soil, steep, 7%	0.25-0.35
Agricultural land	- Bare packed soil, smooth	0.30-0.60
	- Bare packed soil, rough	0.20-0.50
	- Cultivated rows, heavy soil, no crop	0.30-0.60
	- Cultivated rows, heavy soil, with crop	0.20-0.50
	- Cultivated rows, sandy soil, no crop	0.20-0.40
	- Cultivated rows, sandy soil, with crop	0.10-0.25
	- Pasture, heavy soil	0.15-0.45
	- Pasture, sandy soil	0.05-0.25
	- Woodlands	0.05-0.25
Streets	- Asphaltic	0.70-0.95
	- Concrete	0.80-0.95
	- Brick	0.70-0.85
Unimproved areas		0.10-0.30
Drives and walks		0.75-0.85
Roofs		0.75-0.95

Note: The designer must use judgement to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest C values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should be assigned the highest C values.
Source: American Society of Civil Engineers

Rational Equation Coefficients for SCS Hydrologic Soil Groups (A, B, C, D)
Urban Land Uses

STORM FREQUENCIES OF LESS THAN 25 YEARS												
Land Use	Hydrologic Conditions	HYDROLOGIC SOIL GROUP/SLOPE										
		A			B			C			D	
		0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Paved Areas and Impervious Surfaces		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Open Space, Lawns, etc.	Good	0.08	0.12	0.15	0.11	0.16	0.21	0.14	0.19	0.24	0.20	0.24	0.28
Industrial		0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
Commercial		0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Residential Lot Size 1/8 Acres		0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
Lot Size ¼ Acre		0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.4
Lot Size 1/3 Acre		0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
Lot Size ½ Acre		0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
Lot Size 1.0 Acre		0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35

Source: Maryland State Highway Administration

Rational Equation Coefficients for SCS Hydrologic Soil Groups (A, B, C, D)
Rural Land Uses

STORM FREQUENCIES OF LESS THAN 25 YEARS													
Land Use	Treatment / Practice	Hydrologic Condition	HYDROLOGIC SOIL GROUP/SLOPE										
			A			B			C			D	
			0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Pasture or Range		Good	0.07	0.09	0.10	0.18	0.20	0.22	0.27	0.29	0.31	0.32	0.34	0.35
	Contoured	Good	0.03	0.04	0.06	0.11	0.12	0.14	0.24	0.26	0.28	0.31	0.33	0.34
Meadow			0.06	0.08	0.10	0.10	0.14	0.19	0.12	0.17	0.22	0.15	0.20	0.25
Wooded		Good	0.05	0.07	0.08	0.08	0.11	0.15	0.10	0.13	0.17	0.12	0.15	0.21

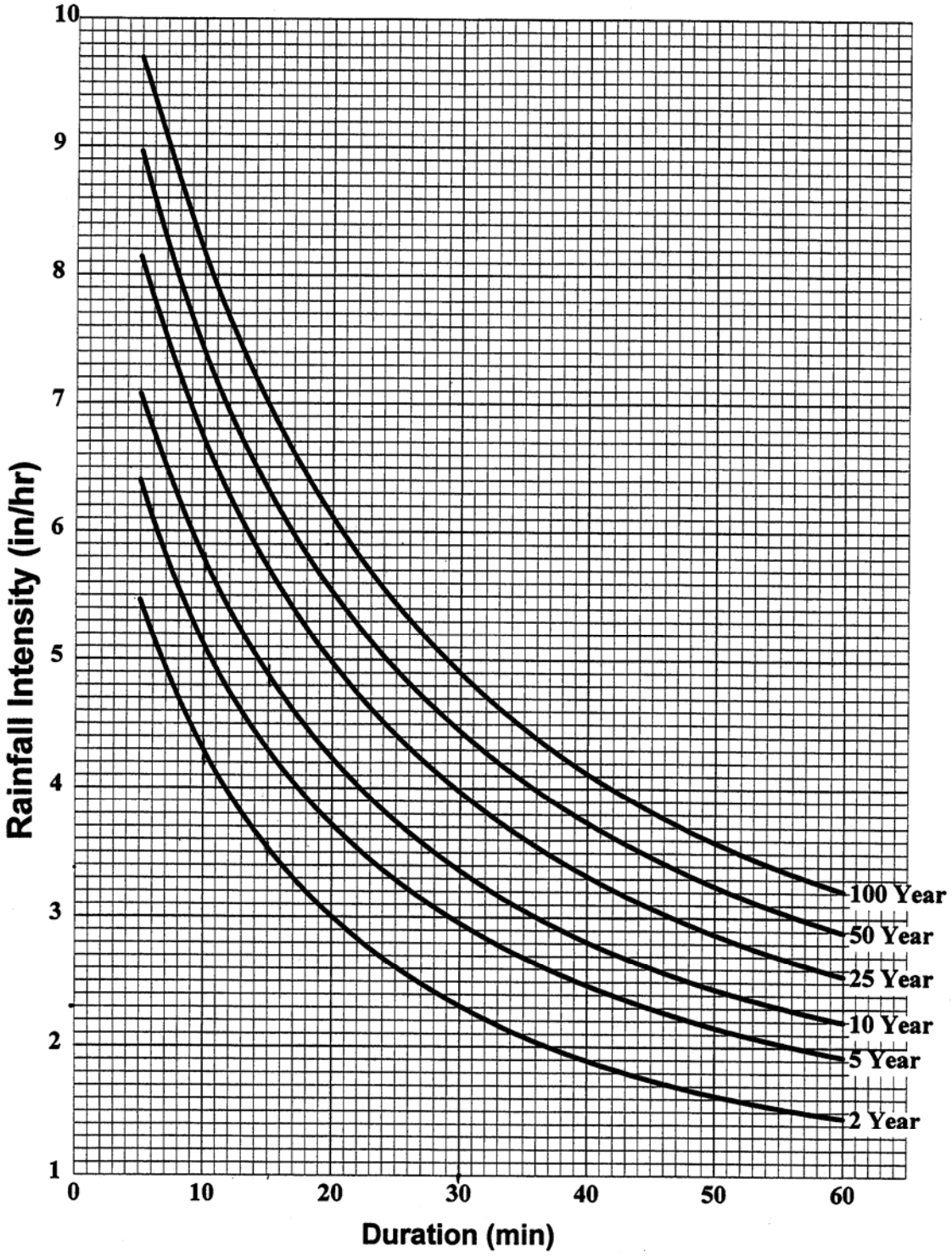
Source: Maryland State Highway Administration

Rational Equation Coefficients for SCS Hydrologic Soil Groups (A, B, C, D)
Agricultural Land Uses

STORM FREQUENCIES OF LESS THAN 25 YEARS													
Land Use	Treatment / Practice	Hydrologic Condition	HYDROLOGIC SOIL GROUP/SLOPE										
			A			B			C			D		
			0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Fallow	Straight Row		0.41	0.48	0.53	0.60	0.66	0.71	0.72	0.78	0.82	0.84	0.88	0.91
Row Crops	Straight Row	Good	0.24	0.30	0.35	0.43	0.48	0.52	0.61	0.65	0.68	0.73	0.76	0.78
	Contoured	Good	0.21	0.26	0.30	0.41	0.45	0.49	0.55	0.59	0.63	0.63	0.66	0.68
	Contoured and Terraced	Good	0.20	0.24	0.27	0.31	0.35	0.39	0.45	0.48	0.51	0.55	0.58	0.60
Small Grain	Straight Row	Good	0.23	0.26	0.29	0.42	0.45	0.48	0.57	0.60	0.62	0.71	0.73	0.75
	Contoured	Good	0.17	0.22	0.27	0.33	0.38	0.42	0.54	0.58	0.61	0.62	0.65	0.67
	Contoured and Terraced	Good	0.16	0.20	0.24	0.31	0.35	0.38	0.45	0.48	0.50	0.55	0.58	0.60
Closed-seeded Legumes or Rotation Meadow	Straight Row	Good	0.15	0.19	0.23	0.31	0.35	0.38	0.55	0.58	0.60	0.63	0.65	0.66
	Contoured	Good	0.14	0.18	0.21	0.30	0.34	0.37	0.45	0.48	0.51	0.58	0.60	0.61
	Contoured and Terraced	Good	0.07	0.10	0.13	0.28	0.32	0.35	0.44	0.47	0.49	0.52	0.54	0.56

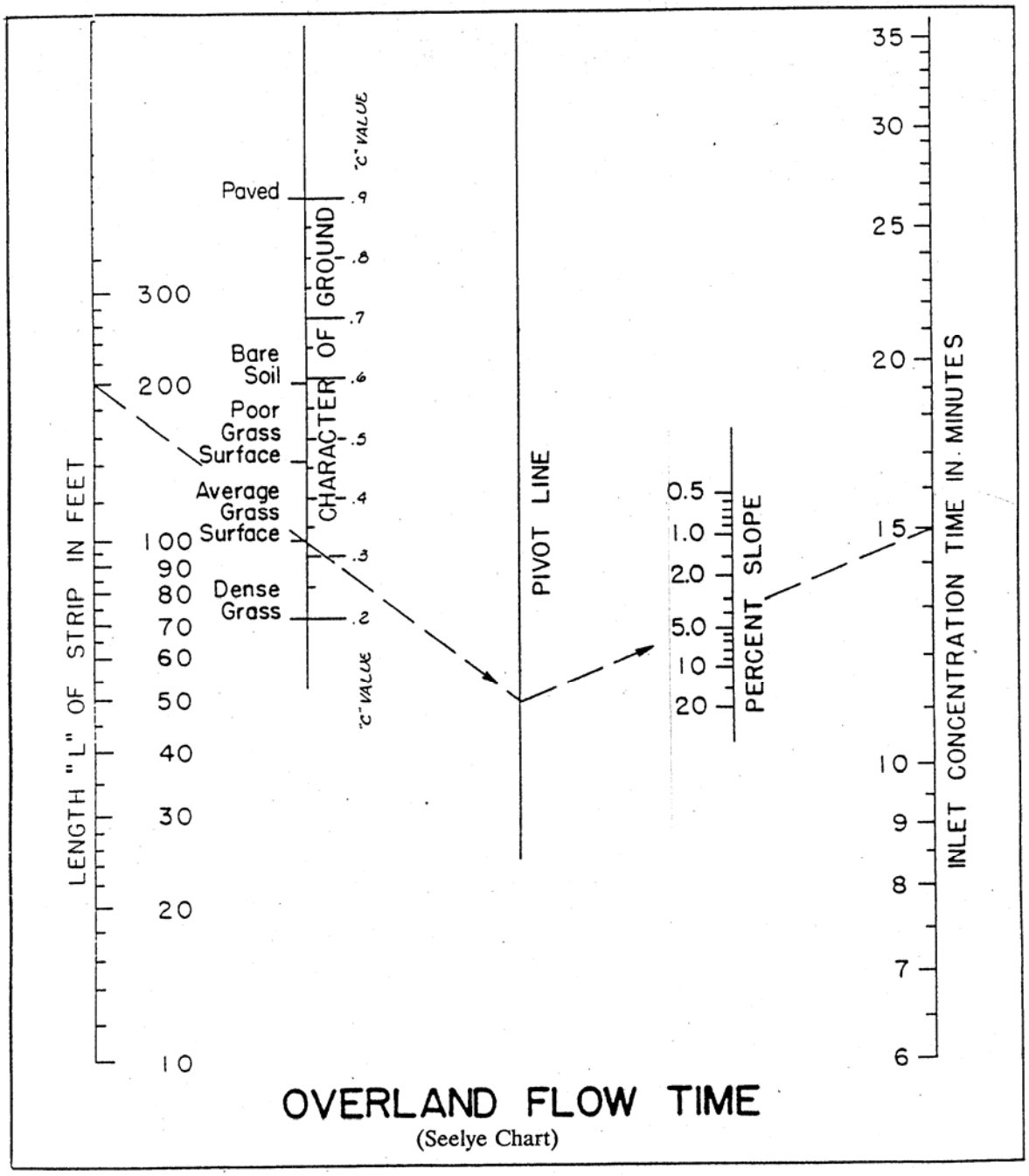
Source: Maryland State Highway Administration

Fauquier County Rational Method IDF Curve

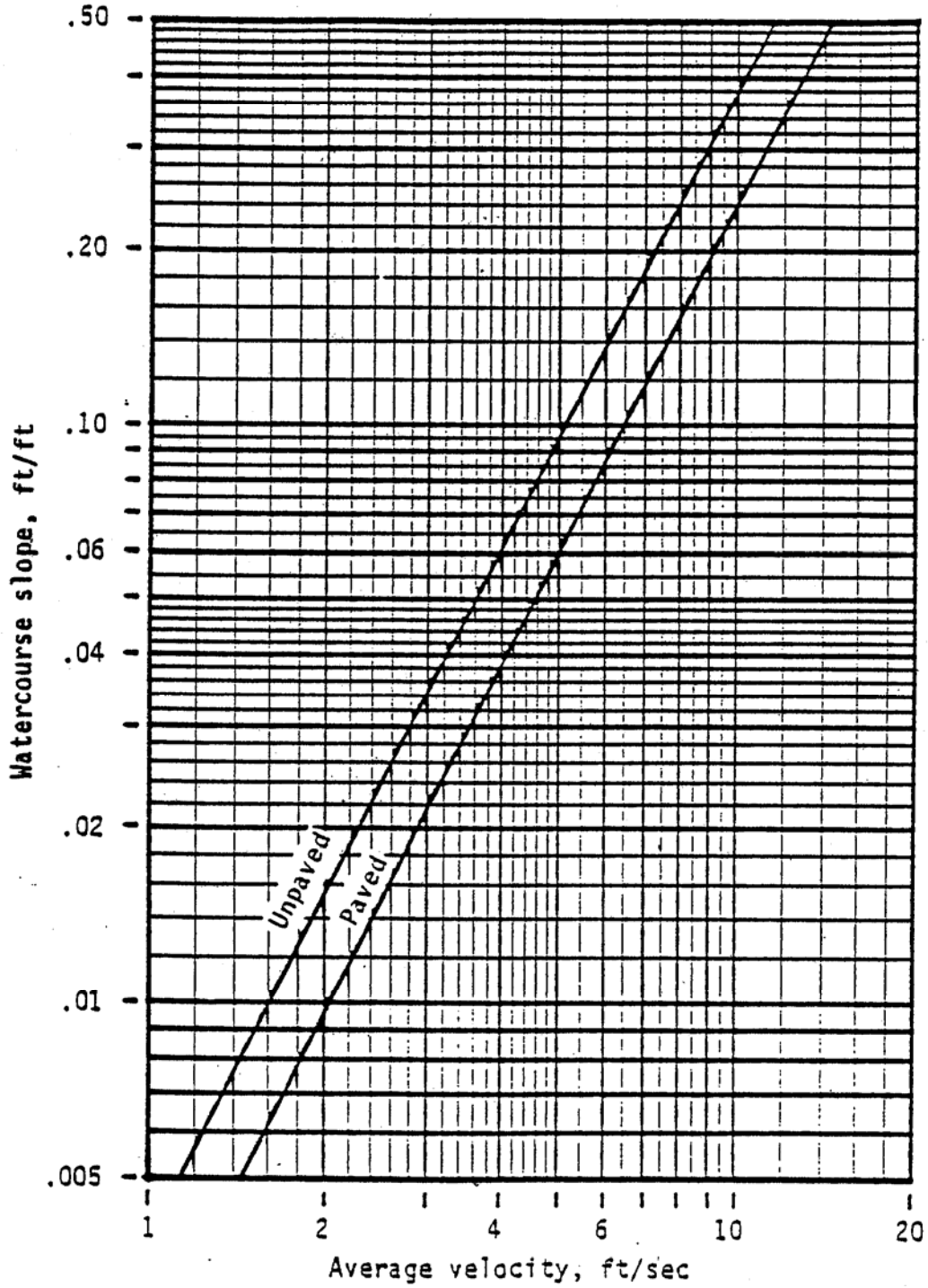


Source: Virginia Stormwater Management Handbook

T_c Calculations



Source: Data Book for Civil Engineers, E. E. Seeyle


.50
.20
.10
.06
.04
.02
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.005
Watercourse slope, ft/ft
Unpaved
Paved
1
2
4
6
10
20
Average velocity, ft/sec

Source: TR-55

T_c and Peak Discharge Sensitivity to Overland Sheet Flow Roughness Coefficients Table

Description	**Manning's 'n'**	**Overland Sheet Flow Time * (hrs.)**	**Pre-Developed Total Time of Concentration, tc (hrs.)**	**2-Yr. Pre-Developed Peak Discharge** (cfs)**
Woods – Light Underbrush	.40	0.75	0.87	8.5
Rangeland - Natural	.13	0.31	0.43	15.0
Woods – Dense Underbrush	.80	1.31	1.43	6.0
* overland flow time calculated using Manning's Kinematic solution (TR-55) ** peak discharge computed using Example 6.1 hydrology in the Virginia Stormwater Management Handbook				

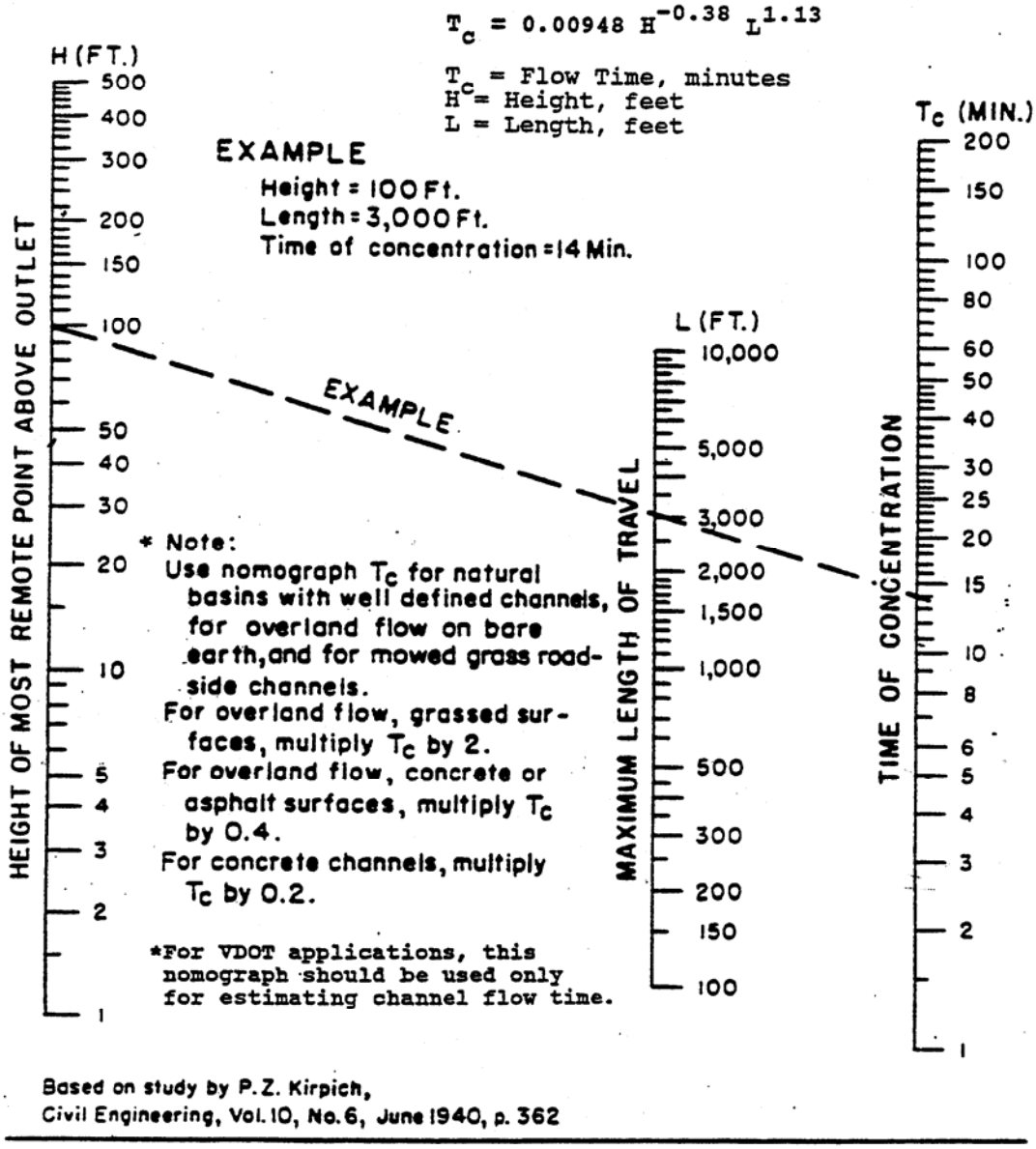
Source: Virginia Stormwater Management Handbook

Roughness Coefficient 'n' for the Manning Equation – Sheet Flow

Surface Description	**'n' Value[1]**
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Soil)	0.011
Fallow (No Residue)	0.05
Cultivated Soils – Residue Cover < 20%	0.06
Cultivated Soils – Residue Cover > 20%	0.17
Grass – Short Grass Prairie	0.15
Grass – Dense Grasses[2]	0.24
Grass – Bermuda grass	0.41
Range (Natural)	0.13
Woods[3] – Light Underbrush	0.40
Woods[3] – Dense Underbrush	0.80
[1] The 'n' values are composite of information compiled by Engman (1986).	
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass and native grass mixtures.	
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.	

Source: Virginia Stormwater Management Handbook

Refer to Chapter 4 of the Virginia Stormwater Management Handbook for further explanations of calculating time of concentration.



TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

The Virginia Department of Transportation derived an equation from and added it to this nomograph. This was done without the author's permission in the interest of providing the user with an optional mathematical solution. The Department warrants neither the accuracy nor the validity of this equation and cautions the user that he uses it at his own risk.

Source: VDOT Drainage Manual

SCS Runoff Curve Numbers

Refer to TR-55 for general assumptions and limitations. For specific footnotes, see TR-55 Table 2-2a - d.

Runoff Curve Numbers for Urban Areas*

Cover Description		**Curve Numbers for Hydrologic Soil Groups**			
Cover Type and Hydrologic Condition	**Average Percent Impervious Area**	**A**	**B**	**C**	**D**
Fully developed urban areas (vegetation established):					
Open space (lawns, parks, golf courses, cemeteries, etc.) Good Condition (grass cover > 75%)		39	61	74	80
Impervious areas: Paved Parking lots , roofs, driveways, etc. (excluding right-of-way) Streets and Roads: Paved; curbs and storm sewers (excluding right-of-way) Paved; open ditches (including right-of-way) Gravel (including right-of-way) Dirt (including right-of-way)		 98 98 83 76 72	 98 98 89 85 82	 98 98 92 89 87	 98 98 93 91 89
Urban districts: Commercial and business Industrial	 85 72	 89 81	 92 88	 94 91	 95 93
Residential districts by average lot size: 1/8 acre or less (town houses) ¼ acre 1/3 acre ½ acre 1 acre 2 acres	 65 38 30 25 20 12	 77 61 57 54 51 46	 85 75 72 70 68 65	 90 83 81 80 79 77	 92 87 86 85 84 82
Developing Urban Areas:					
Newly graded areas (pervious areas only, no vegetation) Idle lands (CN's are determined using cover types similar to those in TR-55 Table 2-2c)		77	86	91	94
* Average runoff condition and $I_a = 0.2S$					

Source: TR-55 adapted Table 2-2a.

Runoff Curve Numbers for Cultivated Agricultural Lands*

Cover Description			Curve Numbers for Hydrologic Soil Groups			
Cover Type	**Treatment**	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Fallow	Bare Soil	-	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
	CR	Good	74	83	88	90
Row Crops	Straight row (SR)	Poor	72	81	88	91
	SR	Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
	SR + CR	Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
	C	Good	65	75	82	86
	C + CR	Poor	69	78	83	87
	C + CR	Good	64	74	81	85
	Contoured & Terraced (C&T)	Poor	66	74	80	82
	C&T	Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
	C&T + CR	Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
	SR	Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
	SR + CR	Good	60	72	80	84
	C	Poor	63	74	82	85
	C	Good	61	73	81	84
	C + CR	Poor	62	73	81	84
	C + CR	Good	60	72	80	83
	C&T	Poor	61	72	79	82
	C&T	Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
	C&T + CR	Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
	SR	Good	58	72	81	85
	C	Poor	64	75	83	85
	C	Good	55	69	78	83
	C&T	Poor	63	73	80	83
	C&T	Good	51	67	76	80
* average runoff condition and $I_a = 0.2S$						

Source: TR-55, Table 2-2b

Runoff Curve Numbers for other Agricultural Lands*

Cover Description		**Curve Numbers for Hydrologic Soil Groups**			
Cover Type	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Pasture, grassland, or range-continuous forage for grazing	Poor	68	79	86	89
Pasture, grassland, or range-continuous forage for grazing	Fair	49	69	79	84
Pasture, grassland, or range-continuous forage for grazing	Good	39	61	74	80
Meadow–continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush–brush-weed-grass mixture with brush the major element	Poor	48	67	77	83
Brush–brush-weed-grass mixture with brush the major element	Fair	35	56	70	77
Brush–brush-weed-grass mixture with brush the major element	Good	30	48	65	73
Woods-grass combination (orchard or tree farm)	Poor	57	73	82	86
Woods-grass combination (orchard or tree farm)	Fair	43	65	76	82
Woods-grass combination (orchard or tree farm)	Good	32	58	72	79
Woods	Poor	45	66	77	83
Woods	Fair	36	60	73	79
Woods	Good	30	55	70	77
Farmsteads-buildings, lanes, driveways, and surrounding lots	-	59	74	82	86
*Average runoff condition and $I_a = 0.2S$					

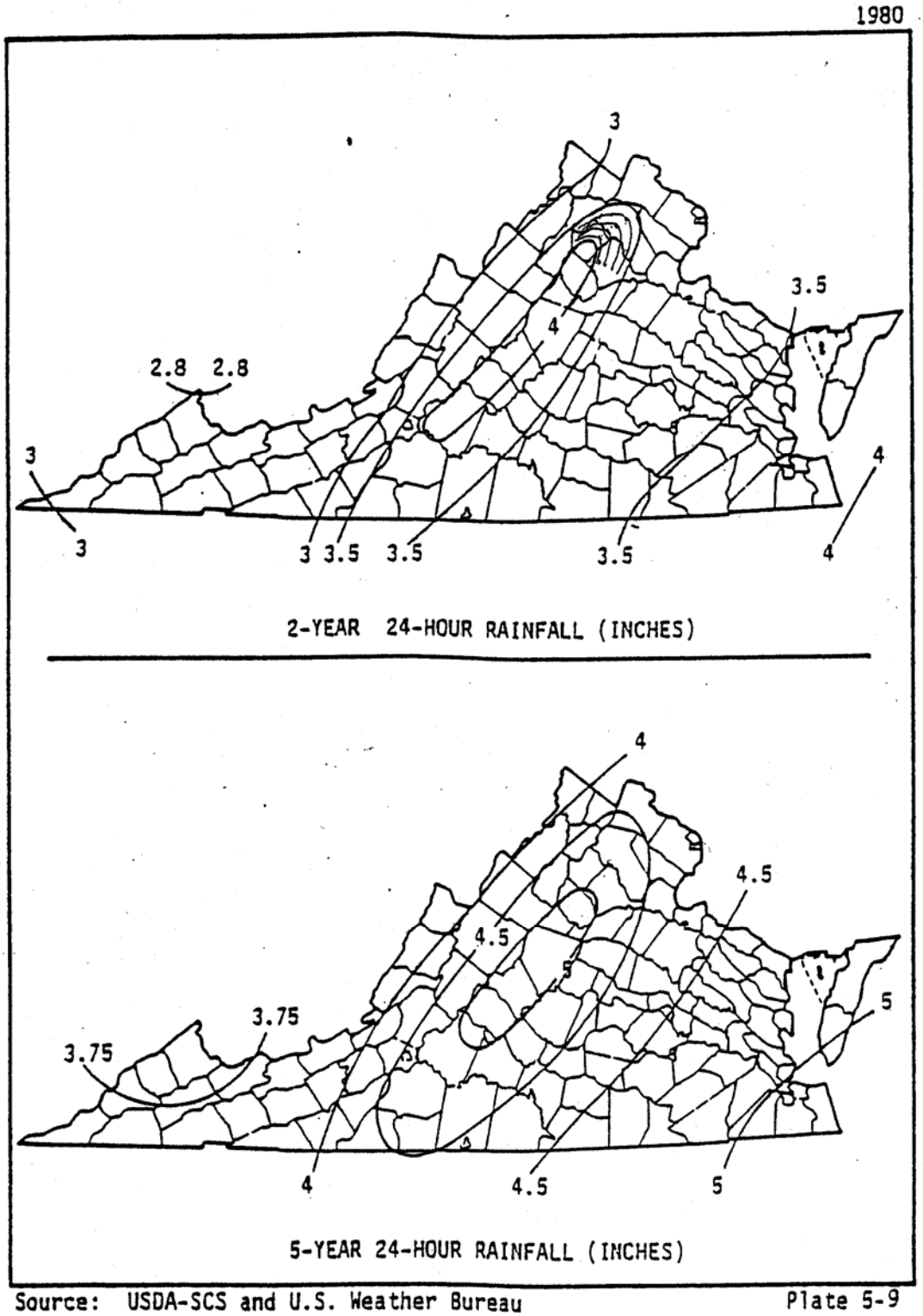
Source: TR-55, Table 2-2c

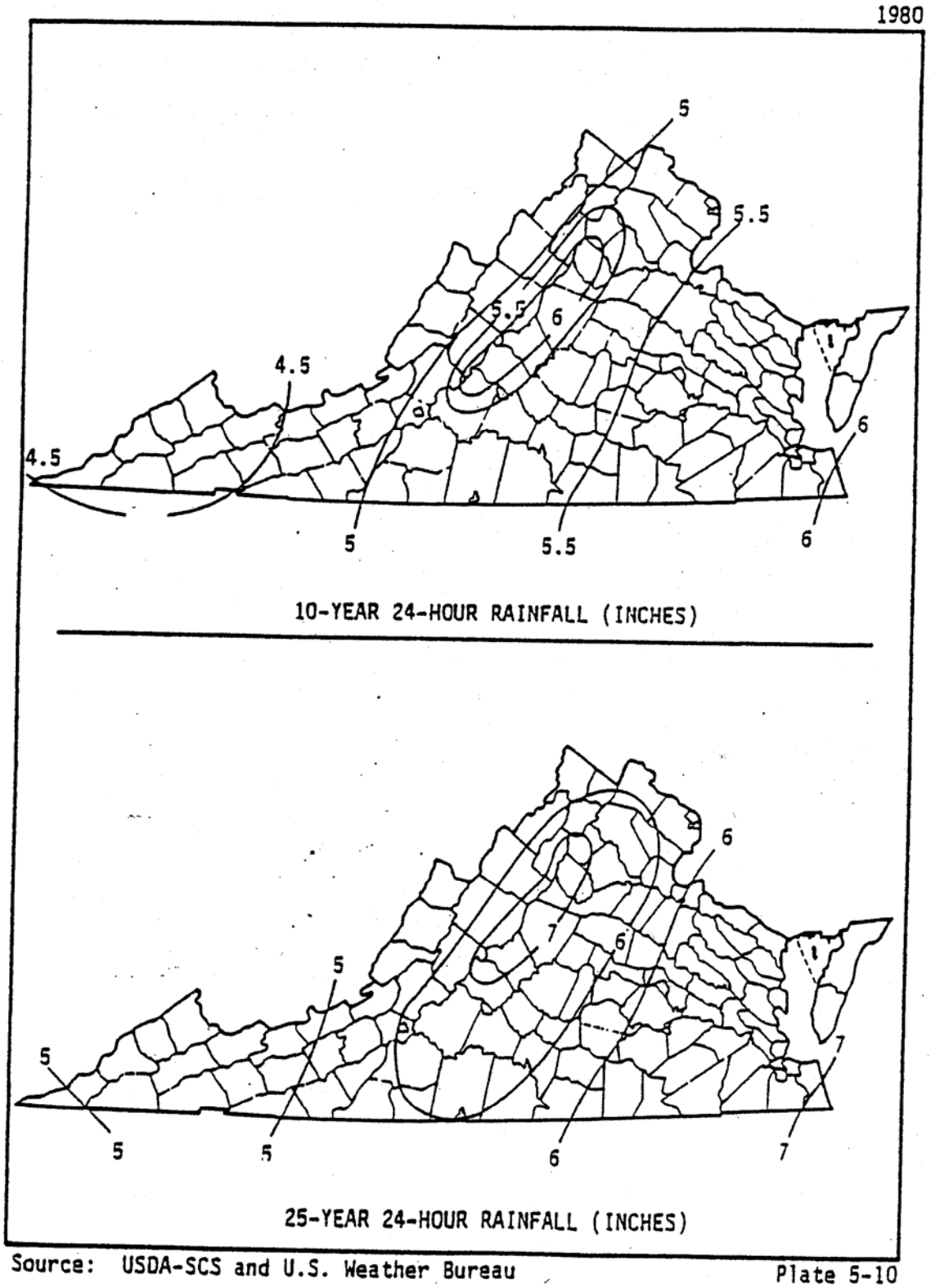
Runoff Curve Numbers for arid and semiarid rangelands*

Cover Description		Curve Numbers for Hydrologic Soil Groups			
Cover Type	**Hydrologic Condition**	**A**	**B**	**C**	**D**
Herbaceous - mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor		80	87	93
Herbaceous - mixture of grass, weeds, and low-growing brush, with brush the minor element	Fair		71	81	89
Herbaceous - mixture of grass, weeds, and low-growing brush, with brush the minor element	Good		62	74	85
Oak-aspen - mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple and other brush	Poor		66	74	79
Oak-aspen - mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple and other brush	Fair		48	57	63
Oak-aspen - mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple and other brush	Good		30	41	48
Pinyon-juniper – pinyon, juniper or both; grass understory	Poor		75	85	89
Pinyon-juniper – pinyon, juniper or both; grass understory	Fair		58	73	80
Pinyon-juniper – pinyon, juniper or both; grass understory	Good		41	61	71
Sagebrush with grass understory	Poor		67	80	85
Sagebrush with grass understory	Fair		51	63	70
Sagebrush with grass understory	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite and cactus	Poor	63	77	85	88
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite and cactus	Fair	55	72	81	86
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite and cactus	Good	49	68	79	84
*Average runoff condition and $I_a = 0.2S$, For range in humid conditions use preceding table					

Source: TR-55, Table 2-2d

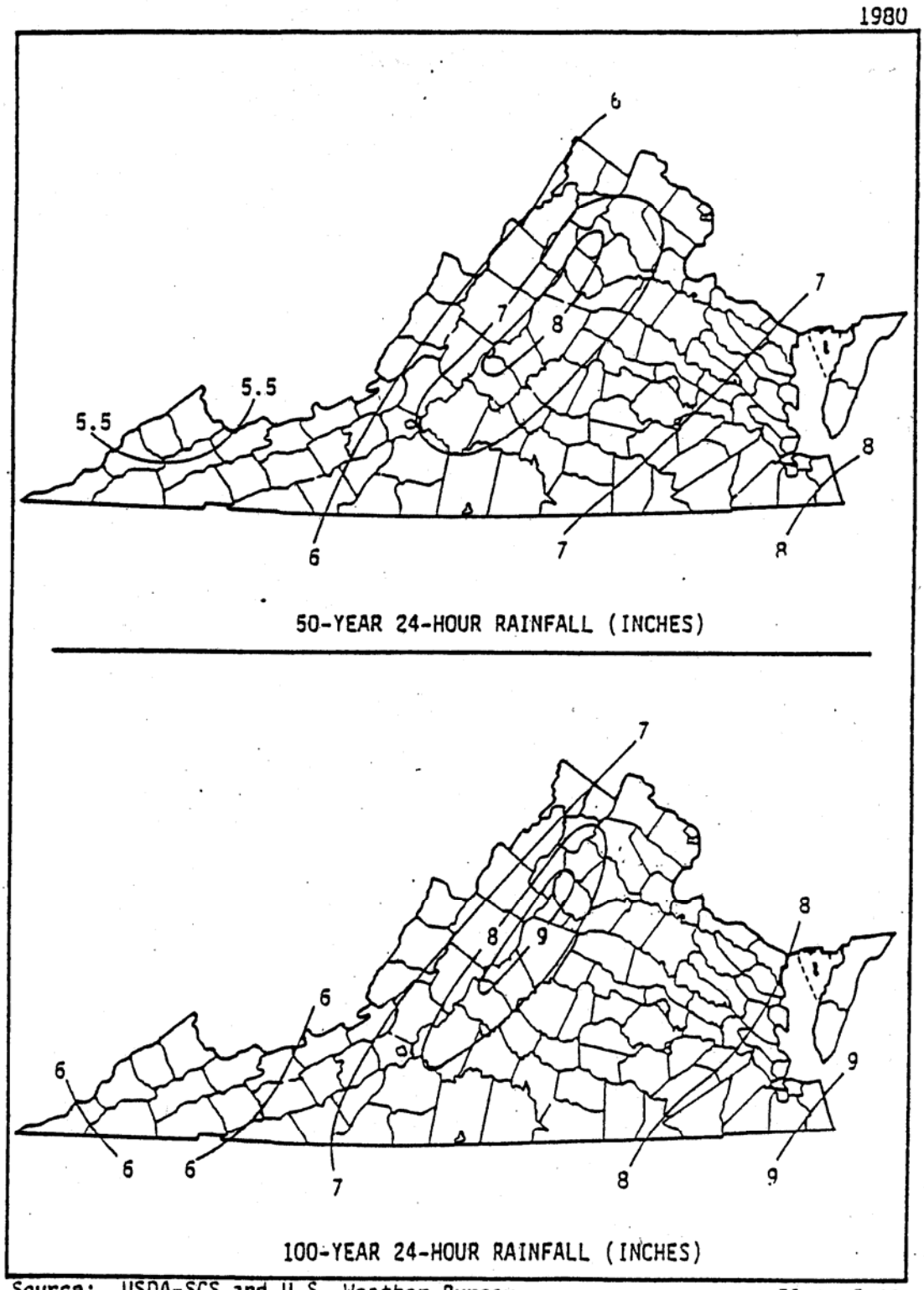
SCS Rainfall Depths





Source: USDA-SCS and U.S. Weather Bureau

Plate 5-10



Source: USDA-SCS and U.S. Weather Bureau

Plate 5-11

Mannings Channel 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. Natural Streams			
1. **Main Channels**			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. **Flood Plains**			
a. Pasture no brush			
1. Short Grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated Areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. **Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged**			
a. Bottom: gravels, cobbles and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070
B. Lined or Built-Up Channels			
1. **Concrete**			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	

Type of Channel and Description	Minimum	Normal	Maximum
2. **Concrete bottom float finished with sides of:**			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonary, plastered	0.016	0.020	0.024
d. Cement rubble masonary	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. **Gravel bottom with sides of:**			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. **Brick**			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. **Metal**			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. **Asphalt**			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
7. **Vegetal lining**	0.030		0.500
C. Excavated or Dredged Channels			
1. **Earth, straight and uniform**			
a. Clean recently completed	0.016	0.018	0.020
b. Clean after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. **Earth, winding and sluggish**			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050
3. **Dragline-excavated or dredged**			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. **Rock Cuts**			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. **Channels not maintained, weeds and brush**			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

Source: Virginia Stormwater Management Handbook

Permissible Channel Velocities

Permissble Velocities for Grass-Lined Channels Table

Channel Slope	Lining	Velocity* (ft./sec.)
0 – 5%	Bermudagrass	6
	Reed canarygrass Tall fescue Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains Temporary vegetation	2.5
5 – 10%	Bermudagrass	5
	Reed canarygrass Tall fescue Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Bermudagrass	4
	Reed canarygrass Tall fescue Kentucky bluegrass	3
* For highly erodible soils, decrease permissible velocities by 25%		

Source: Soil and Water Conservation Engineering, Schwab, et. al. and American Society of Civil Engineers.

Permissible Velocities for Unlined Earthen Channels Table

Soils Types	Permissible Velocity (ft./sec.)
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncollodial)	2.5
Silt Loam (noncollodial)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very collodial)	5.0
Graded, Loam to Cobbles (noncollodial)	5.0
Graded, Silt to Cobbles (noncollodial)	5.5
Alluvial Silts (noncollodial)	3.5
Alluvial Silts (collodial)	5.0
Coarse Gravel (noncollodial)	6.0
Cobbles and Shingles	5.5
Shales and Hard Pans	6.0

Source: American Society of Civil Engineers